Use of a phase-resolving model for wave breaking prediction

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In the past 20 years, significant efforts have been made to simulate accurately wave conditions in shallow water and the surf zone for a variety of nearshore activities and environmental issues. The motivation for recent studies in coastal engineering are mostly centered on the need for accurate predictions of the height and location of breaking waves in the surf zone and on the need for estimating detailed wave characteristics at the breaking point [1, 2]. Breaking waves create significant dynamical loading on ocean engineering structures. Optimal structural design requires accurate predictions of the maximum nonlinear wave forces expected over the structure’s working lifetime. Most hydrodynamic models are based on phase-averaged methods in which only integral wave parameters are calculated. The present study focuses on phase-resolving models and more particularly Boussinesq-type models whose main advantage is to describe individual wave characteristics and not wave parameters. In contrast to the nonlinear shallow water equations, traditional Boussinesq models cannot simulate directly the effects of wave breaking in shallow water. Many efforts have been made to extend these equations and include the effects of wave breaking. This requires two steps: the introduction of a wave breaking criterion and the introduction of breaking wave energy dissipation [3, 4]. Nowadays, Boussinesq models have been shown to be effective even in situation with complex bathymetry and strong non-linear phenomenon [5, 6]. Extensive research on breaking waves is going on and a universal wave breaking criterion has not been identified yet [7].

This study will focus on the deterministic wave-by-wave prediction of breaking waves with the BOSZ model [8]. The wave breaking criteria implemented in BOSZ is based on the deactivation of dispersion terms. From a literature review, different wave breaking criteria have been identified such as the criterion of [3] based on the wave steepness of the front, the criterion of [4] based on the vertical speed of the free surface, the Relative Trough Froude Number (RTFN) criterion [9], the Breaking Celerity Index [1]. They will be implemented in the BOSZ model and compared to 1D and 2D experiments to identify which criterion is most appropriate to take into account the effects of wave breaking with the BOSZ model.

References